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Ostracods and lithofacies close to the Eifelian-Givetian boundary (Devonian) at Aisemont (Namur Synclinorium, Belgium)

by Jean-Georges CASIER & Alain PRÉAT

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Abstract

The paper presents the sedimentological analysis and the ostracod study of the upper part of the Rivière Fm. and of the stratotype of the Névremont Fm. in the Aisemont section, the reference section for the Eifelian-Givetian boundary (Devonian) in the southern border of the Namur Synclinorium, Belgium.

Thirteen major microfacies types are defined. Their stratigraphic succession records the transition from a mixed siliciclastic-carbonate ramp (upper Eifelian) to a carbonate platform (lower Givetian).

About 6,350 ostracods were extracted. Forty species (19 in open nomenclature) are recognized in the Rivière Fm. and 48 species (27 in open nomenclature) in the Névremont Fm. They belong exclusively to the Eifelian Mega-Assemblage and their distribution is controlled mainly by water energy and salinity variations.

The sedimentological analysis and the study of ostracods are in good agreement with recent conodont study of GOUWY & BULTYNCK (2003). Our work confirms the position of the Rivière and Névremont formations boundary and highlights a gap of the major part of the Hanonet and Trois-Fontaines formations of the southern Dinant Synclinorium. This hiatus is probably associated with the lowstand systems tract at the Eifelian-Givetian boundary interval in northern France and southern Belgium (PRÉAT, 2004).

The presence of *Quassilites fromelennensis* and *Jenningsina heddebaui*, indicates that a great part of the transitional zone of GOUWY & BULTYNCK (2003) is of Givetian age.

Key words: Ostracods, Microfacies, Eifelian, Givetian, Namur Synclinorium, Belgium.

Résumé

Nous présentons ici l'analyse sédimentologique et l'étude des ostracodes de la partie supérieure de la Formation de Rivière et du stratotype de la Formation de Névremont dans la coupe d'Aisemont. Cette coupe sert aussi de référence pour la limite Eifélien/Givétien au bord sud du Synclinorium de Namur.

L'analyse sédimentologique des formations de Rivière et de Névremont permet de reconnaître une séquence standard de 13 microfacies montrant le passage de milieux marins ouverts peu profonds aux milieux hypersalins proches de l'émersion.

Environ 6.350 carapaces, valves et fragments d'ostracodes ont été extraits de la coupe d'Aisemont. Quarante espèces (19 en nomenclature ouverte) sont reconnues dans la Formation de Rivière, et 48 (27 en nomenclature ouverte) dans la Formation de Névremont. Elles appar-

tiennent exclusivement au Méga-Assemblage de l'Eifel et leur distribution est contrôlée principalement par l'agitation des eaux et par de fortes variations de salinité.

L'analyse sédimentologique et l'étude des ostracodes justifient la position de la limite des formations de Rivière et de Névremont et confirment les corrélations avec le bord sud du Synclinorium de Dinant établies à l'aide des conodontes par GOUWY & BULTYNCK (2003). La majeure partie des formations d'Hanonet et de Trois-Fontaines du bord sud du Synclinorium de Dinant est absente au niveau de la transition Eifélien-Givétien au bord sud du Synclinorium de Namur (Aisemont). Cet hiatus est probablement lié à la présence d'un cortège de bas niveau marin à la transition Eifélien-Givétien au Nord de la France et au Sud de la Belgique (PRÉAT, 2004).

La présence de *Quassilites fromelennensis* et de *Jenningsina heddebaui*, indique qu'une grande partie de la zone de transition de GOUWY & BULTYNCK (2003) est d'âge givétien.

Mots-clefs: Ostracodes, Microfacies, Eifélien, Givétien, Namur Synclinorium, Belgique.

Introduction

Late Eifelian and early Givetian ostracods are poorly known in the Namur Synclinorium (Belgium) in comparison to those of the Dinant Synclinorium [see for example COEN (1985), CASIER & PRÉAT (1990; 1991) and CASIER *et al.* (1992)]. In the Namur Synclinorium, only a few ostracod species have been reported from the Aisemont section by BULTYNCK (1970), and from the Givetian of Alvaux and Sombreffe by MAGNE (1964). Consequently we have undertaken the study of ostracods close to the Eifelian-Givetian boundary in the Aisemont section, a well known regional reference section for this boundary, and the stratotype of the Névremont Fm. The aim of our paper is to establish the inventory of ostracods and to document the environmental changes close to the Eifelian-Givetian boundary.

The Aisemont railway section – General setting

The Aisemont section (Fig. 1) is located in the southern part of the Namur Synclinorium, between milestones 6.1 and 6.2 of the dismantled Dinant-Charleroi railway, and close to a quarry belonging to the "Société des Carrières et Fours à Chaux d'Aisemont" (GPS: N 50°23'967;

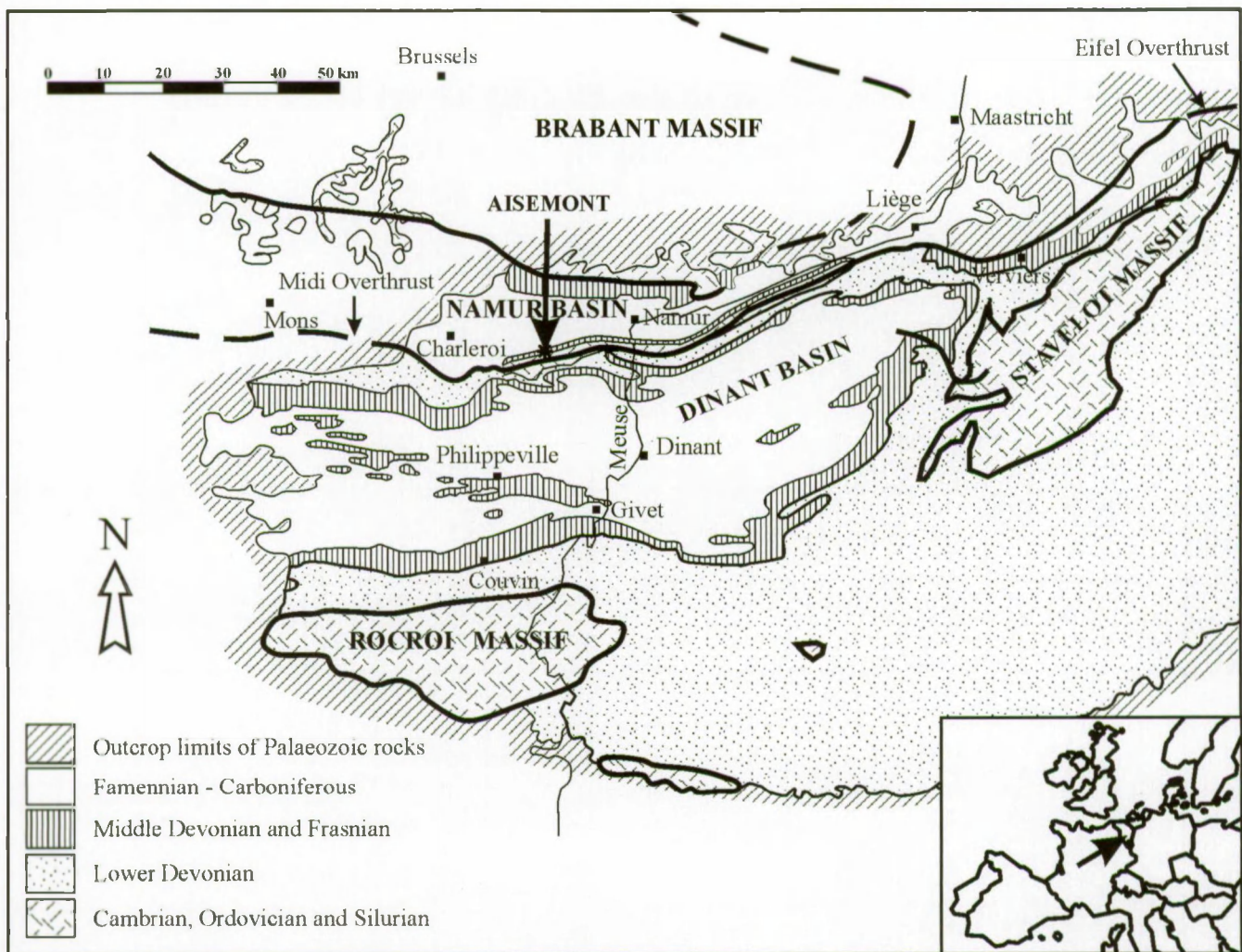


Fig. 1 — Location of the Aisemont section on a geological map of Southern Belgium and neighbouring countries (adapted from Bultynck *et al.*, 2001).

E 4°37'982). The section exposes the upper part of the Rivière Fm. (Claminforge Member), the stratotype of the Nèvremon Fm., the Roux Fm. and the base of the Presles Fm. (see BULTYNCK *et al.*, 1991 for the definition and limits of these formations). Only the two first of the preceding formations are studied herein.

The Aisemont section has been studied and described by LECOMTE (1960), BULTYNCK (1966, 1970), LACROIX (1974), PRÉAT (1984), COEN-AUBERT (2000) and GOUWY & BULTYNCK (2003). The Eifelian-Givetian boundary occurs in a thin silty-sandy limestone unit in the upper part of the Rivière Fm. (GOUWY & BULTYNCK, *ibid.*).

GOUWY & BULTYNCK (*ibid.*) have recognized the *ensis* Zone, the Lower *varcus* Zone and a Middle *varcus* Zone – Upper *varcus* Interval in the Aisemont section, but they could not positively recognize the *hemiansatus* Zone. They also reported a sedimentary gap 60 cm below the Rivière Fm. and the Nèvremon Fm. boundary, just below their sample KB15. They correlated deposits below this sample with those of the uppermost part of the Jemelle Fm., and the deposits above this sample to the Hanonet Fm. and to a great part of the Trois-Fontaines

Fm. These formations are located in the southern border of the Dinant Synclinorium. They correlated also the lower part of the Nèvremon Fm. with the lower part of the Terres d'Haus Fm. On the other hand, COEN-AUBERT (2000, 2002) placed the boundary between the Rivière

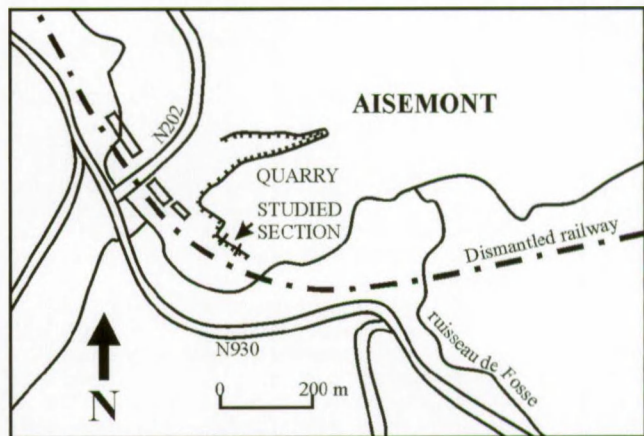


Fig. 2 — Geographic location of the Aisemont section.

Fm. and the Névremont Fm. a little lower in the series, and correlated the entire Névremont Fm. with the Mont d'Haus Fm.

Rock and facies analysis (A. PRÉAT)

Introduction

The Aisemont profile was studied by PRÉAT (1984). Two-hundred and seventeen samples were collected for sedimentology in the Rivière and Névremont formations (thickness: around 92 m, the top is not exposed). The Rivière Fm. is composed of calcareous shales overlain by fine laminated siltstones. The Névremont Fm. consists of thin to medium, well-bedded limestones at the base and more massive thicker oolite dolostones in the upper part. The base of the Névremont Fm. is placed at the first limestone above the silty-shaly layers of the Rivière Fm., as defined by GOUWY & BULTYNCK (2003). This corresponds to our sample number 419 (Fig. 3b) collected at the top of this bed.

PRÉAT (1984) and PRÉAT & MAMET (1989) developed a standard microfacies sequence of 13 major microfacies types (MF) for the Givetian and correlated them with the corresponding microfacies of the idealised standard microfacies (SMF) sequence of WILSON (1975). The microfacies analysis of the Aisemont profile was established by PRÉAT (1984) and will not be discussed here. This author showed that the Givetian sedimentation was controlled by metric regressive cycles (or "rhythms"). A complete cycle within the restricted facies belt (lagoonal environment in PRÉAT & MAMET, 1989) consists of a subtidal to lower intertidal unit overlain by an upper intertidal-supratidal unit recording upward-shoaling conditions. A synthesis of the processes controlling the cyclicity on the Givetian platform has recently been published by PRÉAT (2004).

The aim of the sedimentological study of this article is to highlight the major evolution of the environments and to see if the ostracod ecology is sensitive to this evolution. Another point is related to the recent study of GOUWY & BULTYNCK (2003) on the conodont faunas near the Eifelian-Givetian boundary (E-G). These authors reported a gap in the uppermost Eifelian and lowermost Givetian and it was of great interest to see if sedimentological data support this conclusion.

Two logs have been established. Since the profile is completely covered by dense vegetation (the railway has been dismantled for more than 20 years), a general log (Fig. 3a) has been drawn from the data of PRÉAT's PhD thesis (1984). A few old samples from this thesis have been treated for the ostracod study and Fig. 3a gives their stratigraphic position (see column 1 in Fig. 3a) following the sample labels of PRÉAT (1984). A second log (Fig. 3b) has been established at the E-G boundary after clearing the vegetation of this part of the profile. Fig. 3b indicates the stratigraphic position of the newly collected samples (samples 401 to 440, column 1, Fig. 3b). The general stratigraphical position of this log is also indicated on

Fig. 3a. Not all samples of Fig. 3b have been treated for ostracods.

Thin sections permit recognition of the following 13 microfacies types which parallel the standard sequence of PRÉAT & MAMET (1989).

Microfacies description

Open marine near or within the storm wave base (MF1, 2, 3)

Microfacies type 1 (or MF1)

Definition: shaly, clayey, micaceous siltstones and silty microbioclastic mudstones-wackestones with thin levels of bioclastic packstones. Bioclasts consist mainly of crinoids, brachiopods (some with spines), ostracods and rare bryozoans. The matrix (Pl. 5, Fig. 1) is strongly burrowed with accumulation of silty quartz grains and contains fine-grained fragments of organic matter (around 50 µm). The matrix also contains fine-grained pyrite and abundant pyritospheres of the same type as those described by CASIER *et al.* (2004). Pressure solution processes are well developed in the clayey facies forming a "pseudonodular" texture (Pl. 5, Fig. 1).

Microfacies type 2 (or MF2)

Definition: clayey and silty burrowed wackestones and laminar silty peloidal packstones with various bioclasts (echinoderms, bryozoans, ostracods, molluscs, brachiopods). Organisms are present as large unmicritized and micritized fragments in millimetric laminae (up to 2 mm thick), or as small irregular lenses. Millimetric bioturbation features are well developed and obliterate the primary laminations. The micritic matrix can be rich in fine-grained fragments of organic matter fragments (same as in MF1) and contains pyritized echinoderm and brachiopod bioclasts. Pyrite and pyritospheres are abundant and display various morphotypes including filaments. Very fine-grained pyrite (< 5 microns) is present inside the muddy grains (peloids, lumps), which are therefore blackened ("black grains"), and inside the micritic matrix.

Microfacies type 3 (or MF3)

Definition: laminar bioclastic and peloidal wackestones and packstones. The bioclasts are diversified and coarser than in the previous facies. The silty fraction is still present but decreases. Small-sized pyrite, pyritospheres are as abundant as in MF1 and 2, but "blackened" fine-grained encrustations on large bioclasts: iron-encrustations or iron infiltration of the bioclasts (Pl. 5, Figs. 2, 3), ferruginization of bryozoan zoecia (Pl. 5, Fig. 2; DELLA PORTA *et al.*, 2003; MAMET & PRÉAT, 2005), iron corrosion or iron encrustation of crinoids and gastropods. The bioclasts (micritized or not, pyritized or not) form millimetric layers. They display high angle oblique stratifications or form elongated lenses. The bioturbation is less pronounced (Pl. 5, Fig. 2). The matrix of the packstones is often recrystallized in a homogeneous fine-grained calcitic microspar. The echinoderm fragments can be very abundant (encrinite).

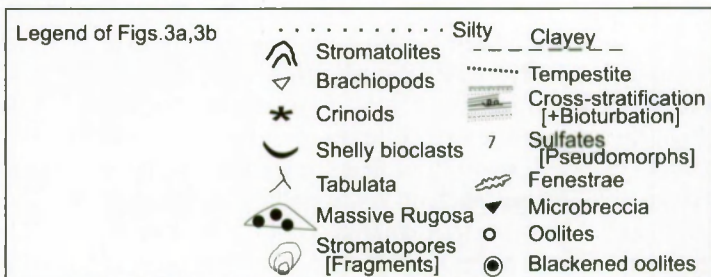
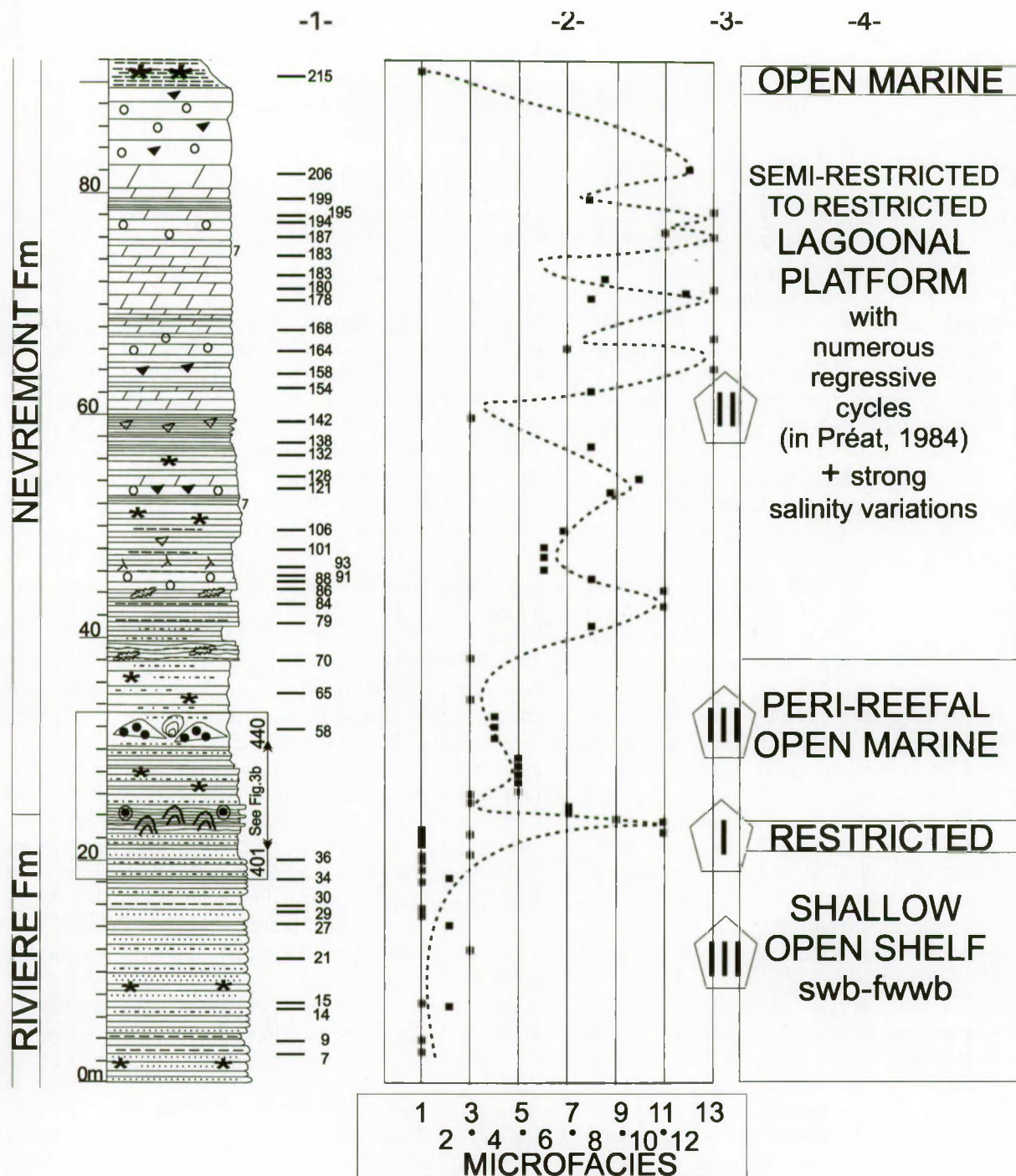


Fig. 3a — Lithological column of the Aisemont section. Column 1: position of sedimentological and ostracod samples (following the numeration of Pr  at 1984); column 2: standard sequence of the 13 microfacies (after PR  AT & MAMET, 1989); column 3: ostracod assemblages (after CASIER, 1987); column 4: paleoenvironmental interpretation. Abbreviations: SWB = normal storm wave base; FWWB = normal fair-weather wave base.

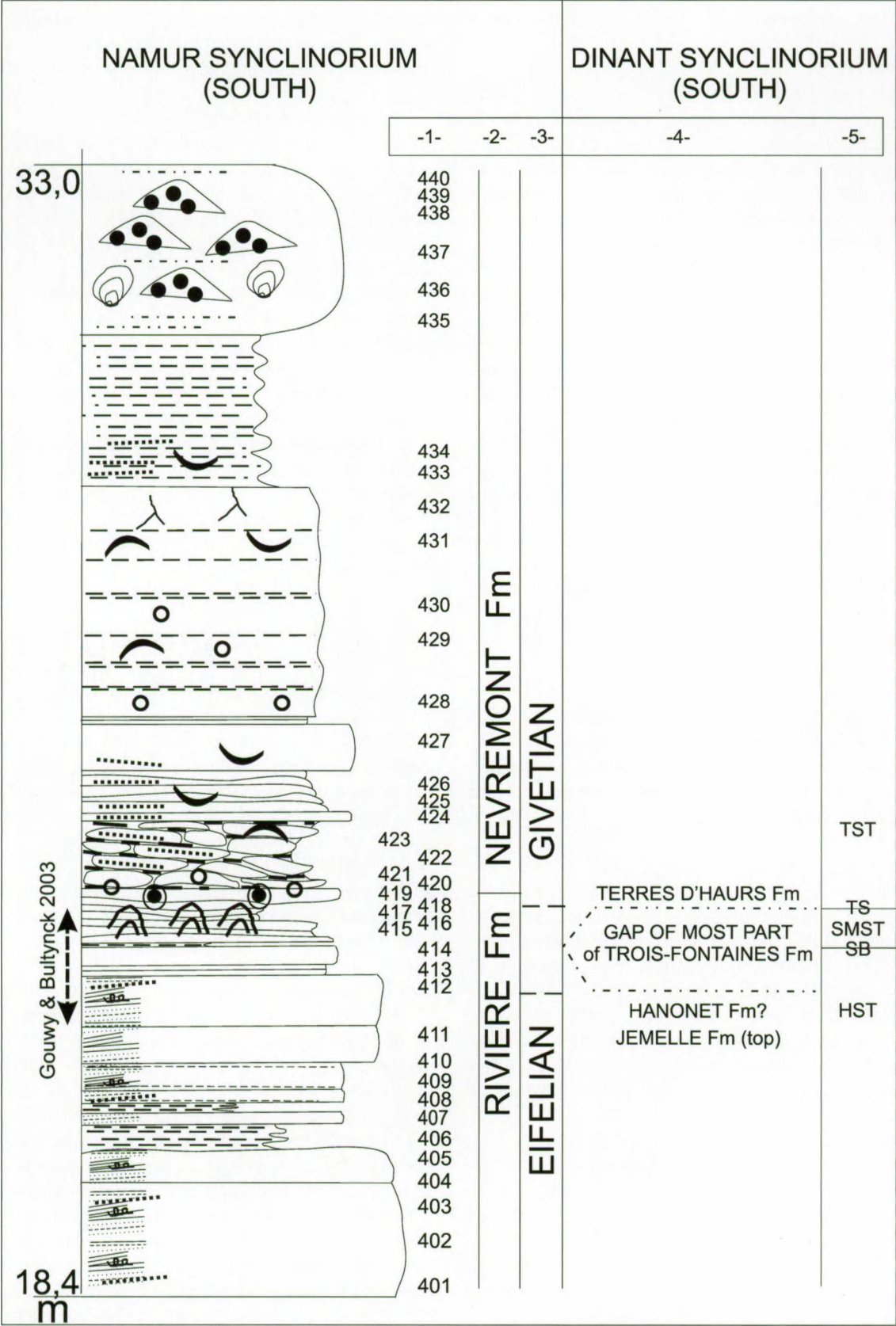


Fig. 3b — Detail of the Eifelian-Givetian boundary interval of Aisemont section (see general position in Fig. 3a). Column 1: new sampling of our study; column 2: lithostratigraphy; column 3: stratigraphy; column 4: correlation with the formations of the southern border of Dinant Basin (*in* GOUWY & BULTYNCK, 2003); column 5: sequential stratigraphy (HST = highstand systems tract; SB = sequence boundary; SMST = shelf margin systems tract; TS = transgressive surface; TST = transgressive systems tract). The vertical arrow (right of the log) corresponds to the E-G transitional zone of GOUWY & BULTYNCK (2003). Legend for symbols: see figure 3a.

Open marine, peri-reefal near or within the fair-weather wave base (MF4, 5, 6 and 7)

Microfacies type 4 (or MF4)

Definition: coral (massive Rugosa with a few massive thamnoporids) floatstones and rudstones (Pl. 5, Fig. 4). Bioclasts are coarser and consist of echinoderms, molluscs, ostracods and archaeogastropods. A few stromatoporeoid fragments are associated. The slightly clayey matrix is micritic and partly dolomitized.

Microfacies type 5 (or MF5)

Definition: bioturbated bioclastic wackestones and packstones with thick (centimetric) bioclastic layers. The bioclasts are thicker and dominated by non-micritized and micritized molluscs (bivalves and gastropods) whose accumulations lead to the formation of thin "lumachelles" or coquina beds. A few fragments of echinoderms, bryozoans, ostracods and corals are associated; coral fragments are encrusted by *Girvanella*. Blackened bioclastic grains (black pebble type) (Pl. 5, Figs. 5, 6) and "blebs" (strongly bio-corroded blackened grains, *sensu* MAMET & PRÉAT, 2005) are common and associated with the bioclastic layers. The matrix is often recrystallized in a homogeneous fine-grained calcitic microspar containing small-sized pyrite (Pl. 5, Fig. 6).

Microfacies type 6 (or MF6)

Definition: peloidal floatstones and rudstones with corals, molluscs, brachiopods, echinoderms, palaeosiphonocladacean algae and rare ammonoids. Numerous subrounded and poorly sorted micritic microbreccias are present and associated with mud-coated grains.

Microfacies type 7 (or MF7)

Definition: oolitic packstones and grainstones (Pl. 5, Figs. 7, 8) with molluscan shells, bryozoans, ostracods and crinoids. Oolites are micritized or ferruginized and their nuclei consists of a micritized ferruginized (pyrite) bioclast (crinoid, ostracod, gastropod, Pl. 6, Figs. 1, 2). Abundant blackened grains and "blebs" (PRÉAT *et al.*, 2005) are observed. A poorly to well developed laminar structure with cross-stratification is present despite the bioturbation. Grains are well sorted. Dolomitization of the matrix is weak.

Restricted environments with salinity fluctuations (MF8 to 13)

Microfacies type 8 (or MF8)

Definition: very fine- to fine-grained peloidal packstones with abundant microbioclasts (mainly ostracods) forming irregular lenses or dispersed in the sediment.

Microfacies type 9 (or MF9)

Definition: algal (*Kamaena*, *Issinella*) wackestones, packstones and cryptalgal bindstones with abundant *Bevoastria*, *Ortonella* (Pl. 6, Fig. 3), ostracods and calcispheres (*in* PRÉAT, 1984). Few molluscs are observed.

Irregular fenestrae partly filled with a peloidal sediment are present in the homogeneous micrite matrix. The matrix contains abundant pyritospheres.

Microfacies type 10 (or MF10)

Definition: spongiostromid packstones and bindstones. This microfacies is rare in the Aisemont profile and has been reported in the upper part of the Névremont Fm. (near 80 m in Fig. 3a, PRÉAT, 1984).

Microfacies type 11 (or MF11)

Definition: loferites and peloidal stromatolitic bindstones with abundant ostracods (Pl. 6, Figs. 5, 6) displaying joined carapaces and few calcispheres. Thin irregular desiccation cracks are present in the matrix which is partly composed of a very fine grained greyish calcite microspar. The matrix contains abundant laminoid fenestrae. Cryptalgal chips sometimes become numerous that the sediment becomes a microconglomerate. Proto-oolites and small micritized grains are mixed with the microbreccia (Pl. 6, Fig. 4). Small-sized subrounded lumps with numerous *Palaeomicrocodium* are present (Pl. 6, Fig. 7).

Microfacies type 12 (or MF12)

Definition: laminar peloidal packstones with smooth flat millimetric laminations (Pl. 6, Fig. 8) similar to those of Andros Island (HARDIE & GINSBURG, 1977). The millimetric layering is formed by the alternation of thin levels of muddy sediments and thicker layers of well-sorted peloidal (nodular codiaceans?) microbioclastic (ostracods, molluscs) packstones. Desiccation cracks, tubular and laminoid fenestrae are common.

Microfacies type 13 (or MF13)

Definition: very fine grained dolomudstones with rare blackened grains (black pebble type) and a small percentage of silty quartz. Rare pisoids.

Microfacies and paleoenvironmental interpretations

1. *Microfacies types 1 to 7*: The texture of the rocks (mudstones to packstones) associated with the different characteristics of the laminae record the relative paleobathymetry of the storm (SWB) and the fair-weather (FWWB) wave bases (EINSELE & SEILACHER, 1982; AHR, 1989). The laminar levels, which are rare and thin (MF1), of intermediate thickness despite the bioturbation (MF2) and finally thick and abundant (MF3), contain similar bioclasts. The size of the bioclasts increases with lamination thickness and with the complexity of the biotic assemblages. Massive Rugosa (mainly temnophyllids and spinophyllids; see COEN-AUBERT, 2002) are important in microfacies type 4 and indicate the presence of a bioconstruction. This barrier seems effective since no important restricted facies belt is associated (see the biostromal unit at 30 m, Fig. 3a).

Peri-reefal facies consist of bioclastic accumulations ("lumachelles" or coquina beds of MF5) and of open-marine organisms mixed with semi-restricted microflora

(MF6) indicating the progressive influence of the lagoonal environments through oolite channels (MF7).

2. Microfacies types 8 to 13: The restricted environments are dominated by nodular cyanophyceans and calcispheres in the subtidal zones (MF8 and MF9), by laminoid cyanophycean mats in the intertidal parts (spongiostromids, loferites and intraformational microbreccias MF10 and MF11) and by stromatolitic bindstones and laminites in the supratidal zones (MF12). Dolomudstones of MF13 cap this sequence and indicate hypersalinity related to the development of sebkha deposits which will be the rule in the overlying Roux Fm. (PRÉAT, 1984). Most organisms of the open marine environments (MF1-MF7) have been replaced by endemic fauna (ostracods, molluscs) or specific microflora (cyanophyceans and calcispheres).

3. General setting: These characteristics suggest a mixed siliciclastic carbonate ramp system for the Eifelian succession. The sedimentation is influenced by the respective SWB and FWB positions (WRIGHT & BURCHETTE, 1998). Microfacies type 1 with rare thin bioclastic levels is located near the base of the SWB. The thin bioclastic laminae without erosive surfaces in MF1 are interpreted as distal tempestites. Layers of moderate thickness in MF2 represent intermediate tempestites and the thicker bioclastic levels of MF3 represent proximal tempestites. In this general context, the background sedimentation is decantation of clayey and silty carbonate muds in quiet environments (AIGNER, 1985). Bioturbation processes predominate. These microfacies are similar to those reported by PRÉAT & KASIMI (1995) in the Belgian-French Middle Devonian, by MAMET & PRÉAT (2002) in the Devonian-Carboniferous of the French Avesnes Basin, and by SEBBAR *et al.* (2000) in the Algerian Carboniferous Tindouf Basin. Oblique and cross-bedding become frequent in MF5, 6 and 7 and indicate high-energy levels near the FWB where bioconstructions or shoals formed (MF4). As a consequence of the progressive development of the reefal barrier, a lagoonal environment developed in the major part of the Névremont Fm. This indicates that a carbonate platform system, the rule during the Early Givetian, may have replaced the Eifelian ramp. This general evolution has been reported on a wider scale (the Dinant Synclinorium) by PRÉAT (2004).

Sedimentological and palaeoecological evolutions

Based on the interpretation of the lithologic curve the series can be subdivided into several units (Fig. 3a):

Shallow open shelf or ramp (Rivière Fm.)

From 0 to 22.3 m: thin, medium- to thick-bedded shaly-silty mudstones and wackestones interstratified with thin shales in a shallow open shelf between the storm and fair-weather wave bases. Distal tempestites are present throughout most of the interval and proximal tempestites only in the upper part. The fauna is not abundant due to the high terrigenous input but well diversified

microbioclasts and bioclasts (echinoderms, brachiopods, bryozoans, molluscs) points to a well-oxygenated environment. This is also suggested by the ostracods (Assemblage III *sensu* CASIER, 1987). This dominantly outer ramp succession is thicker since it starts at least 20 m below (PRÉAT, 1984). The influence of semi-restricted lagoons is obvious at the top of the interval (sample 412, Figs. 3a and 3b) where abundant Platycopina and Metacopina are present in the proximal tempestites.

Restricted lagoon (Névremont Fm.)

From 22.3 to 23.2 m: thin interval composed of cryptalgal bindstones with whole ostracods trapped in the mats. The previous open-marine fauna is absent and the environment is near emersion (irregular desiccation cracks). Ostracods indicate semi-restricted to restricted conditions (Assemblage I).

Peri-reefal open marine shelf (Névremont Fm.)

From 23.2 to 38 m: medium to thick bedded clayey nodular limestones interstratified with thin blackish shales. Open-marine fauna is diversified (molluscs, brachiopods, crinoids, bryozoans, Tabulata thamnoporids, Rugosa and stromatopores). Thin coquina beds are common and indicate proximal tempestites. Ostracod association is similar to that of the first interval (Assemblage III) indicating sedimentation between the SWB and FWB levels. Oolites, present in the first bed of the interval, are associated with blackened grains.

Semi-restricted to restricted carbonate platform (Névremont Fm.)

From 38 to 89.2 m: thin to medium bedded wackestones, packstones and fine-grained dolostones with abundant algal microflora (*Kamaena*, *Issinella*), cryptalgal mats, calcispheres and ostracods. Fenestral fabrics are well developed in the lower part and very-fine grained dolomicrites with a few sulfate pseudomorphs in the upper part. Oolites and microbreccia are observed throughout the interval (PRÉAT, 1984). The absence of open-marine fauna (except for a few thin layers in the lower part with crinoids and brachiopods) points to a restricted lagoon evolving to hypersaline environments at the top. Salinity fluctuations were the rule as indicated by the repetition of metric subtidal-supratidal regressive cycles (PRÉAT, 1984; PRÉAT & MAMET, 1989). Ostracods are either absent or form monospecific communities typical of Assemblage II.

Open marine environment (Névremont Fm.)

From 89.2 m to the top of the formation (92 m?, not shown here due to poor exposure): open-marine shales with abundant brachiopods and crinoids.

Sequence stratigraphy

Based on conodont biostratigraphy (GOUWY & BULTYNCK, 2003) the one m thick transitional zone (Fig. 3b) is correlated with the uppermost part of the Jemelle Fm., the Hanonet Fm. and the major part of the Trois-Fontaines Fm. in the southern part of the Dinant Synclinorium.

COEN-AUBERT (2002) proposed a slightly different correlation pattern on the base of the rugose coral distribution: the Terres d'Haus Fm. (southern border of Dinant Synclinorium) is correlated with the upper part of the Rivière Fm., and the Névremont Fm. is correlated with the Mont d'Haus Fm. of the Dinant Synclinorium. In her schema the Trois-Fontaines Fm. is correlated with the middle part of the Rivière Fm.

Our microfacies analysis permits recognition of at least two remarkable surfaces or sedimentary discontinuities and three systems tracts (Fig. 3b):

- a sequence boundary (SB, Fig. 3b) underlies an abrupt facies change at the top of the shallow open shelf (Fig. 3a): supratidal cryptalgal or stromatolitic bindstones (restricted supratidal environments) overlie silty clayey mudstones (subtidal environments between the SWB and FWB levels);
- a transgressive surface (TS, Fig. 3b) is present at the top of the previous bindstones and marked by oolites and reworked blackened grains associated with open marine bioclasts (crinoids, bryozoans). Ferruginous and bio-corroded grains are abundant and suggest reworking after a period of starvation or non deposition (RIOULT *et al.*, 1991);
- three different systems tracts are delimited by these two first order discontinuities: a highstand transgressive systems tract below the SB (HST, Fig. 3b) composed of siltstones and bioclastic silty limestones (MF1-3) forming various shoals between the SWB and FWB levels; a shelf margin systems tract (SMST, Fig. 3b) corresponding to a highly restricted lagoon occurring between the SB and TST surface, and a transgressive systems tract (TST, Fig. 3b) with coquina beds (mainly molluscs) and reefal bioconstructions.

Our sedimentological analysis confirms the important gap of the Trois-Fontaines Fm. revealed by GOUWY & BULTYNCK (2003): the TS surface corresponds to the base of the “third biostrome” (or base of the Terres d'Haus Fm.) of the southern part of the Dinant Synclinorium (PRÉAT *et al.*, 1984) and the SMST interval corresponds to the Trois-Fontaine Fm. as also suggested by conodonts (GOUWY & BULTYNCK, 2003) and ostracods (see below). The SB discontinuity is marked at the south border of the Dinant Synclinorium by a beach-rock level of regional extension (PRÉAT, 2004; MAMET & PRÉAT, 2005) overlying open-marine facies and preceding the important lagoonal episode characteristic of most parts of the Trois-Fontaines Fm. The first restricted environments observed at Aisemont correspond to this entire lagoonal phase. KASIMI & PRÉAT (1996) have shown that the E-G transition in the southern border of the Dinant Synclinorium records the transition of a mixed ramp to a carbonate platform. This evolution is diachronic (PRÉAT, 2004) and could be stepwise at Aisemont as suggested by the recurrence of open marine facies above the restricted facies at the E-G transition.

Ostracods of the Aisemont section (J.-G. CASIER)

Sampling and extraction of ostracods

Sixty-five samples of about 500 g each were collected for ostracods in the Aisemont section (Fig. 3a,b), 27 in the Rivière Fm. and 38 in the Névremont Fm. Ostracods were extracted by the hot acetolysis method (LETHIERS & CRASQUIN-SOLEAU, 1988). Each sample was crushed with a hydraulic press and dried. About 100 g of each sample was attacked with glacial acetic acid 99.8%, close to 90°C, for four days at the rate of seven hours a day. The residue was sieved with 100 µm, 250 µm, and 1600 µm mesh sieves. For rich samples and samples collected very close to the Eifelian-Givetian boundary, the part of the sample held back by the 1600 µm mesh sieve was attacked once more and sieved with 250 µm and 1600 µm mesh sieves only.

About 6,350 carapaces, valves and fragments of ostracods identifiable at any taxonomic level were extracted from the section, 2,375 in the Rivière Fm. and the rest in the Névremont Fm.

Systematic position of ostracod species in the Aisemont section

Order Palaeocopida HENNINGSMOEN, 1953

Suborder Palaeocopina HENNINGSMOEN, 1953

Superfamily Kirkbyacea ULRICH & BASSLER, 1906

Family Amphissitidae KNIGHT, 1928

- *Amphissites tener omphalotus* BECKER, 1964 (Pl. 1, Figs. 1a,b, 2).
- *Amphissites* sp. A (Pl. 1, Fig. 3).

Superfamily Beyrichiacea MATTHEW, 1886

Family Beyrichiidae MATTHEW, 1886

- *Kozłowskiella boloniensis* MILHAU, 1983 (Pl. 1, Fig. 4).
- *Kozłowskiella* sp. A BECKER, 1964 (Pl. 1, Figs. 5, 16).
- *Parakosłowskiella?* sp. 3B in MILHAU, 1988.

Superfamily Youngiellacea KELLETT, 1933

Family Youngiellidae KELLETT, 1933

- *Youngiella* sp. A, aff. *Ostracode* indet. F5 in MAGNE (1964) (Pl. 1, Fig. 6a,b).

? Superfamily Kirkbyacea ULRICH & BASSLER, 1906

Family Scrobiculidae POSNER, 1951

- *Roundyella* cf. *patagiata* (BECKER, 1964) (Pl. 1, Fig. 7a,b).

Superfamily Primitiopsacea SWARTZ, 1936

Family Primitiopsidae SWARTZ, 1936

- *Parapribylites hanaicus* POKORNY, 1950 (Pl. 1, Fig. 8a,b).

- *Kielciella fastigans* (BECKER, 1964) (Pl. 1, Fig. 9a,b).

Family Graviidae POLENOVA, 1952

- *Coryellina curta* (ROZHDSTVENSKAJA, 1959) (Pl. 1, Fig. 10a,b).

- *Coryellina* sp. A (Pl. 1, Fig. 11a,b).

? Family Buregiidae POLENOVA, 1953

- *Buregia ovata* (KUMMEROW, 1953) (Pl. 1, Fig. 12a,b).

Superfamily Hollinacea SWARTZ, 1936

Family Hollinidae SWARTZ, 1936

- *Hollinella* cf. *praecursor* POKORNY, 1950 (Pl. 1, Fig. 13).
- *Hollinella* sp. indet. (Pl. 1, Fig. 14).

Superfamily Aparchitacea JONES, 1901

Family Aparchitidae JONES, 1901

- *Ochescapha plana* (KUMMEROW, 1939) (Pl. 1, Fig. 15 a,b).
- *Ochescapha*? sp. A, aff. *semicircularis* (KUMMEROW, 1953) (Pl. 1, Fig. 17a,b).
- *Coeloenellina vellicata* COEN, 1985 (Pl. 2, Fig. 1a,b).
- *Coeloenellina*? sp. A (Pl. 2, Fig. 2a,b).

Superfamily unknown

Family Aechminellidae SOHN, 1961

- *Balantoides* sp. A, aff. *brauni* (BECKER, 1968) (Pl. 2, Fig. 3a,b).

Family Kirkbyellidae SOHN, 1961

- *Refrathella struvei* BECKER, 1967 (Pl. 2, Fig. 4).

Suborder Paraparchiticopina GRAMM in GRAMM & IVANOV (1975)

Superfamily Paraparchitacea SCOTT, 1959

Family Paraparchitidae SCOTT, 1959

- *Samarella* sp. A (Pl. 2, Figs. 5a,b, 6).
- Paraparchitidae? indet. (Pl. 2, Fig. 16a,b).

Suborder Platycopina SARS, 1866

Superfamily Cytherellacea SARS, 1866

Family Cavellinidae EGOROV, 1950

- *Cavellina devoniana* EGOROV, 1950 *sensu* COEN (1985) (Pl. 2, Fig. 7a,b).
- *Cavellina* sp. A, aff. *devoniana* EGOROV, 1950 (Pl. 2, Fig. 8a,b).
- *Uchtovia* cf. *abundans* (POKORNY, 1950) (Pl. 2, Fig. 9 a,b).

Superfamily Kloedenellacea ULRICH & BASSLER, 1908

Family Kloedenellidae ULRICH & BASSLER, 1908

- *Poloniella claviformis* (KULMMEROW, 1953) (Pl. 2, Figs. 10a,b, 11, 12).
- *Poloniella claviformis* (KULMMEROW, 1953) *vel tertia* KRÖMMELBEIN, 1953.
- *Poloniella cuneata* (KULMMEROW, 1953) (Pl. 2, Fig. 13a,b).
- *Evlanella lessensis* CASIER, 1991 (Pl. 2, Fig. 14a,b).
- *Evlanella* sp., aff. *mitis* ADAMCZAK, 1968 (Pl. 2, Fig. 15a,b).

Order Podocopida SARS, 1866

Suborder Metacopina SYLVESTER-BRADLEY, 1961

Superfamily Thlipsuracea ULRICH, 1894

Family Thlipsuridae ULRICH, 1894

- *Polyzygia symmetrica* GÜRICH, 1896 (Pl. 3, Fig. 1a,b).

- *Polyzygia* sp. A, aff. *symmetrica* GÜRICH, 1896 (Pl. 3, Fig. 2).

Family Quasillitidae CORYELL & MALKIN, 1936

- *Quassilites fromelennensis* MILHAU, 1983 (Pl. 3, Figs. 3a,b, 4).
- *Jenningsina heddebauti* MILHAU, 1983 (Pl. 3, Fig. 5a,b).
- *Jenningsina* sp. A, aff. *heddebauti* MILHAU, 1983 (Pl. 3, Fig. 6).
- *Jefina romei* COEN, 1985 (Pl. 3, Fig. 7a,b).

Family Ropolonellidae CORYELL & MALKIN, 1936

- *Ropolonellus kettneri* (POKORNY, 1950) (Pl. 3, Fig. 8a,b).

Family Bufinidae SOHN & STOVER, 1961

- *Bufina schaderthalensis* ZAGORA, 1968 (Pl. 3, Figs. 9a,b, 10).
- *Bufina* sp. A, aff. *schaderthalensis* ZAGORA, 1968 (Pl. 3, Fig. 11a,b).

Superfamily Healdiacea HARLTON, 1933

Family Healdiidae HARLTON, 1933

- *Cytherellina obliqua* (KUMMEROW, 1953) (Pl. 3, Fig. 12a,b).
- *Cytherellina groosae* COEN, 1985 (Pl. 3, Fig. 13).
- *Cytherellina* cf. *perlouga* (KUMMEROW, 1953) (Pl. 3, Fig. 14a,b).
- *Cytherellina*? sp. A, aff. *dubia* (KUMMEROW, 1953) (Pl. 3, Fig. 15a,b).

Suborder Podocopina SARS, 1866

Superfamily Bairdiocypridacea SHAVER, 1961

Family Pachydomellidae BERDAN & SOHN, 1961

- *Tubulibairdia* cf. *clava* (KEGEL, 1932) (Pl. 3, Fig. 16a,b).
- *Tubulibairdia* cf. *seminalis* (KUMMEROW, 1953) (Pl. 3, Fig. 17a,b).
- *Tubulibairdia* sp. A, aff. *marhoumaensis* CASIER, 1985 (Pl. 3, Fig. 18a,b).

Family Bairdiocyprididae SHAVER, 1961

- *Healdianella* sp. A (Pl. 4, Fig. 1a,b).
- *Bairdiocypris rauffi* KRÖMMELBEIN, 1952 (Pl. 4, Fig. 2).
- *Bairdiocypris* sp. A, aff. *lamellaris* ADAMCZAK, 1976 (Pl. 4, Fig. 3a,b).
- *Bairdiocypris* sp. B (Pl. 4, Fig. 4a,b).

Superfamily Bairdiacea SARS, 1888

Family Acratiidae GRÜNDEL, 1962

- *Acratia* sp. G1 in MAGNE (1964) (Pl. 4, Fig. 5a,b).

Family Bairdiidae SARS, 1888.

- *Bairdia paffrathensis* KUMMEROW, 1953 (Pl. 4, Figs. 6a,b, 7).
- *Bairdia* sp. A, aff. *paffrathensis* KUMMEROW, 1953 (Pl. 4, Fig. 8a,b).
- *Bairdia* sp. B, aff. *carinata* POLENOVA, 1960 (Pl. 4, Fig. 9a,b).
- *Bairdia* cf. *singularis* KRÖMMELBEIN, 1954 *sensu* OLEMPKA, 1979 (Pl. 4, Fig. 10).

AISEMONT	RIVIÈRE FORMATION												NÈVREMONT FORMATION									
	10	21	27	30	403	404	408	410	412	415	418	419	420	421	422	424	427	429	430	434		
<i>Bairdiocypris</i> sp. indet	■							■				■			■	■						
<i>Bairdia</i> sp. indet	■		■		■		■				■											
<i>Polzygyia symmetrica</i>		?	?			?	■	■	■			■	?					?	■			
<i>Evlanella</i> sp. , aff. <i>mittis</i>		■		?	■	?																
<i>Cytherellina obliqua</i>					■				?			■		■	■	■	■	■	■			
<i>Poloniella claviformis</i> vel <i>tertia</i>						?			■			■	■		■					■		
<i>Hollinella</i> sp. indet.									■			■	■		■							
<i>Jenningsina heddebauti</i>									■			■	■	■		■	■	■	■	?		
<i>Bairdia paffrathensis</i>									■			■	?	■	■	■			■	■		
<i>Cavellina devoniana</i>									■			■	■	■	■	■	■	■	■	■		
<i>Quassilites fromelennensis</i>									■			■		■	■	?	■		■			
<i>Ochescapha</i> ? sp. A, aff. <i>semicircularis</i>										■												
<i>Cryptophyllus</i> sp. A										■	■									?		
<i>Coryellina curta</i>										■			■	■	■	■			■			
<i>Kozłowskiella boloniensis</i>											■											
<i>Bairdiocypris rauffi</i>											■	■						?				
<i>Buregia ovata</i>											■	■										
<i>Evlanella lessensis</i>											■			?								
<i>Cryptophyllus</i> sp. 3											■		■									
<i>Polzygyia</i> sp. A, aff. <i>symmetrica</i>												■										
<i>Amphissites</i> sp. A												■										
<i>Jefina romei</i>												■										
<i>Bairdia</i> sp. B, aff. <i>carinata</i>												■										
<i>Ropolonellus ketneri</i>														?								
<i>Roundyella</i> cf. <i>patagiata</i>												■	■			■			?			
<i>Samarella</i> sp. A												■	■	■	■	■	■		■			
<i>Ochescapha plana</i>												■	■	?								
<i>Bufina schaderthalensis</i>												?		■	■				■	■		
<i>Tubulibairdia</i> cf. <i>seminalis</i>												■	■	■					?			
<i>Kozłowskiella</i> sp. A												■										
<i>Amphissites tener omphalotus</i>												■		■								
<i>Tubulibairdia</i> cf. <i>clava</i>													■	■	?			■	■			
<i>Parapribylites hanaicus</i>													■				?			■		
<i>Bairdiocypris</i> sp. B																						

NÈVREMONT FORMATION																			AISEMONT		
435	437	58	438	60	65	70	79	91	93	101	106	121	128	132	138	164	199	206		217	
■				■				■			■									<i>Bairdiocypris</i> sp. indet	
	■	■						■				■		■						<i>Bairdia</i> sp. indet	
■										■						■				<i>Polyzygia symmetrica</i>	
				■			?				■					■				<i>Evlanella</i> sp. , aff. <i>mitis</i>	
				■	■	■	?			■	■	■			■	■			■	<i>Cytherellina obliqua</i>	
											■	■			■	■			■	<i>Poloniella claviformis</i> vel <i>tertia</i>	
																				<i>Hollinella</i> sp. indet.	
?																				<i>Jenningsina heddebauti</i>	
■			■	■	■						■	■								■	<i>Bairdia paffrathensis</i>
■				■	■	■	■			■	■	■	■	■	■	■		■	■	<i>Cavellina devoniana</i>	
■				■						■	■				■				■	<i>Quassilites fromelennensis</i>	
																				<i>Ochescapha?</i> sp. A, aff. <i>semicircularis</i>	
																				<i>Cryptophyllus</i> sp. A	
■										■					■					<i>Coryellina curta</i>	
								■												<i>Kozłowskiella boloniensis</i>	
								■												<i>Bairdiocypris rauffi</i>	
										■		■								<i>Buregia ovata</i>	
															■					<i>Evlanella lessensis</i>	
														■			■			<i>Cryptophyllus</i> sp. 3	
																				<i>Polyzygia</i> sp. A, aff. <i>symmetrica</i>	
																				<i>Amphissites</i> sp. A	
																				<i>Jefina romei</i>	
																				<i>Bairdia</i> sp. B, aff. <i>carinata</i>	
																				<i>Ropolonellus kettneri</i>	
																				<i>Roundyella</i> cf. <i>patagiata</i>	
																				<i>Samarella</i> sp. A	
■																				<i>Ochescapha plana</i>	
■				?																<i>Bufina schaderthalensis</i>	
				■			■				■									<i>Tubulibairdia</i> cf. <i>seminalis</i>	
								■			■	■								<i>Kozłowskiella</i> sp. A	
				■				?												<i>Amphissites tener omphalotus</i>	
■																		?	■	<i>Tubulibairdia</i> cf. <i>clava</i>	
															■					<i>Parapribylites hanaicus</i>	
																				<i>Bairdiocypris</i> sp. B	
■																				<i>Poloniella claviformis</i>	
■																				<i>Youngiella</i> sp. A	
■																				<i>Coeloenellina vellicata</i>	
■				■																<i>Kielcella fastigans</i>	
■				■																<i>Orthocypris cicatricosa</i>	
					■															<i>Cavellina</i> sp. A, aff. <i>devoniana</i>	
						■														<i>Balantoides</i> sp. A, aff. <i>brauni</i>	
				■												■			■	<i>Uchtovia</i> cf. <i>abundans</i>	
■				?				■												<i>Bairdiocypris</i> sp. A, aff. <i>lamellaris</i>	
																				<i>Jenningsina</i> sp. A	
■						?														<i>Hollinella</i> cf. <i>praecursor</i>	
																				<i>Coeloenellina?</i> sp. A	
■				■																<i>Cytherellina groosae</i>	
■				■						■										<i>Cytherellina</i> cf. <i>perlonga</i>	
■																				<i>Paraparchitidae?</i> indet.	
■																				<i>Orthocypris?</i> sp. A	
				■																<i>Refrathella struvei</i>	
					■															<i>Tubulibairdia</i> sp. A, aff. <i>marhoumaensis</i>	
					■											■				<i>Poloniella cuneata</i>	
								■												<i>Cytherellina?</i> sp. A, aff. <i>dubia</i>	
									■											<i>Bairdia</i> cf. <i>singularis</i>	
										■						■				<i>Acratia</i> sp. G1	
											■									<i>Healdianella</i> sp. A	
											■									<i>Bairdia</i> sp. A, aff. <i>paffrathensis</i>	
																		■		<i>Coryellina</i> sp. A	
																			■	<i>Bufina</i> sp. A, aff. <i>schaderthalensis</i>	

- *Bairdia* sp. indet
- *Bairdiacypris* sp. indet
- *Orthocypris cicatricosa* COEN, 1985 (Pl. 4, Fig. 11a,b).
- *Orthocypris?* sp. A (Pl. 4, Fig. 12a,b).

Order Eridostraca ADAMCZAK, 1976

- *Cryptophyllus* sp. 3 in MAGNE (1964) (Pl. 4, Fig. 13).
- *Cryptophyllus* sp. A (Pl. 4, Fig. 14).

Distribution of ostracods in the Aisemont section (Table 1)
In the investigated part of the Rivière Fm. the following 11 samples out of 27 are barren for ostracods: 7, 9, 14, 15, 29, 401, 34, 36, 406, 413 and 417. Ostracods are rare in samples 21, 27, 30, 403, 404, 405, 408, and very abundant in samples 412, 419, 420, 421 and 422. Ostracods in sample 405 are unidentifiable. Forty species, of which 19 are in open nomenclature, were recognized in the Rivière Fm.

In the Névremont Fm. the following 13 samples out of 38 are barren for ostracods: 84, 86, 88, 142, 154, 158, 168, 178, 180, 183, 187, 194, and 195. Ostracods are rare in samples 437, 58, 438, 128, and very abundant in samples 424, 427, 430, 435, 93, 101, 106 and 138. Forty-eight species, of which 27 are in open nomenclature, were recognized in the Névremont Fm.

Palaeoecology of ostracods

Ostracods in the Aisemont section belong to the Eifelian Mega-Assemblage (= Eifelian Ökotyp of BECKER in BANDEL & BECKER, 1975; see CASIER, 2004 for the change of denomination). This mega-assemblage indicative of shallow and generally well oxygenated environments is characterized by the presence of Palaeocopina, Platycopina, Metacopina, Podocopina, Eridostraca and Leperditicopina in relative proportions. Several assemblages indicative of lagoonal (Ass. 0 poorly diversified with leperditicopids and or platycopids), semi-restricted (Ass. I more diversified with cryptophylloids, platycopids, palaeocopids, metacopids and rare podocopids), marine agitated within the fair-weather wave action zone (Ass. II with heavy shelled and frequently broken carapaces) and open marine below fair-weather wave base (Ass. III very diversified with all the major groups of ostracods) environments are recognized in this mega-assemblage (CASIER 1987; see Fig. 3 in CASIER & PRÉAT, 2003). The variation of salinity and water energy are the two major factors controlling the distribution of ostracods in the Eifelian Mega-Assemblage.

- *Palaeoecology of ostracods in the Rivière Fm.* (Figs. 2a,b).

In the Rivière Fm. and below the sample 412 (21.8 m), ostracods are absent (samples 7, 9, 14, 15, 29, 401, 34, 36 and 406), or scarce and generally unidentifiable (samples 21, 27, 30, 403, 404, 405, and 408). In samples 10 (4.3 m) and 410 (20.8 m) ostracods are relatively abundant but generally unidentifiable. Nevertheless the presence of *Bairdia* (Podocopina), *Bairdiocypris* (id.) and *Polyzygia*

(Metacopina) in these samples is indicative of open marine conditions, but shallow since *Evlanella* (Platycopina) and *Poloniella* (id.) are present and the Palaeocopina are absent. The environment was very shallow close to fair-weather wave base (Ass. III). The water energy is probably responsible for the absence or for the poor preservation of ostracods in the above-mentioned samples (Ass. II).

In sample 412 (21.8 m), ostracods are extremely abundant (more than 500 ostracods), but are poorly diversified. Only 8 species were recognized. Moreover, *Cavellina devoniana sensu* COEN (1985) (Platycopina) and *Jenningsina heddebauti* (Metacopina) are predominant, and such a mono-specificity is indicative of shallow semi-restricted water conditions (Ass. I). These conditions are also confirmed by the presence of imbricated valves since this arrangement is due to the lapping of waves as observed e.g. on the shore of lakes and sebkhas, and by the rarity of Podocopina indicative of open marine conditions: only one specimen of *Bairdia paffrathensis* is present in sample 412. However the sedimentological analysis indicates that sample 412 corresponds to a proximal tempestite.

In samples 415 (22.4 m) and 417 (22.7 m), ostracods are rare but significantly dominated by the genus *Cryptophyllus* indicating semi-restricted water conditions (Ass. I). The absence of ostracods in two other samples (413 at 21.9 m and 418 at 22.9 m) denotes extreme lagoonal conditions.

- *Palaeoecology of ostracods in the Névremont Fm.* (Fig. 2a).

The ostracod change at the Rivière and Névremont formations boundary is abrupt. The ostracod fauna at the base of the Névremont Fm. and up to sample 435 (30.25 m) is abundant and very diversified with numerous Palaeocopina (16 species), Platycopina (7 species), Metacopina (11 species) and Podocopina (10 species). The supposed filter-feeding ostracods belonging to the Palaeocopina, Metacopina and Platycopina are largely dominant compared to deposit-feeding Podocopina. This indicates a relatively calm, maybe poorly oxygenated environment. This ostracod fauna is indicative of an open marine environment between fair-weather and storm wave bases (Ass. III).

From sample 437 (31.4 m) to 79 (41.5 m) ostracods are rare but the relative abundance of Podocopina in samples 437, 58 and 438 is indicative of a shallow-marine environment close to fair-weather wave base (Ass. III). This environment evolves progressively to semi-restricted conditions (Ass. I) since in samples 60, 65, 70 and 79, the genus *Cavellina*, and to a smaller extent the genus *Poloniella*, prevail. That progressive trend is attested by the presence of several Podocopina in sample 65.

Samples 84 (42.9 m), 86 (43.7 m), and 88 (44.3 m) are barren of ostracods and their absence is probably due to hypersalinity.

From sample 91 (45.2 m) to sample 138 (57.2 m) ostracods are generally abundant and the mono-specificity

prevails anew. The ostracod fauna is largely dominated by *Cytherellina* in samples 91 (45.2 m) and 93 (45.4 m), by *Cavellina*, *Quasillites* and *Poloniella* in sample 101 (47.9 m), by *Cavellina* and *Poloniella* in samples 106 (49.8 m) and 138 (57.2 m), and by *Cavellina* and *Cryptophyllus* in sample 128 (54.5 m). The environment was semi-restricted, but the presence of some Podocopina indicates that the salinity was sometimes close to normal. No ostracods have been found from sample 142 (59.6 m) to sample 195 (75.5 m), with the exception of sample 164 (65.6 m) containing rare *Cavellina*. The environment was probably lagoonal.

Finally, rare ostracods have been found in samples 199 (79.1 m) and 206 (81.6 m) while the rich sample 217 (89.6 m) contains quasi exclusively *Cavellina*, *Bufina*, *Poloniella* and *Quasillites*. The environment was semi-restricted (Ass. I) in the upper part of the Névremont Fm., with a more pronounced marine influence for the last sample.

No assemblage characteristic of true lagoonal environments (Ass. 0) has been recorded either in the Rivi re Fm. or in the N vremont Fm. at Aisemont. A true lagoonal assemblage is well represented in the Trois-Fontaines Fm. at the southern border of the Dinant Basin, where the abundance of Leperditicopida is indicative of brackish environments (CASIER & PR AT, 1991; see also the leperditiid-charophyte assemblage of MALEC *et al.*, 1987).

Comparison with other regions

In the Namur Synclinorium, the next 9 species present in the Aisemont section are known from the Alvaux Member (Bois de Bordeaux Fm.) in the Sombreffe and Alvaux sections (MAGNE, 1964): *Amphissites tener omphalotus*; *Kozłowskiella boloniensis* (= *Kozłowskiella* sp. G); *Hollinella* cf. *praecursor* (= *Hollinella praecursor*?); *Jenningsina heddebauti* (= *Jenningsina* sp. G3); *Cavellina devoniana sensu* COEN (1985) (= *Cavellina* sp. G); *Poloniella claviformis vel tertia* (= *Poloniella ex gr? devonica*); *Cytherellina obliqua* (= *Bythocypris*? sp. G1); *Acratia* sp. G1 and *Cryptophyllus* sp. 3.

In the Dinant Synclinorium, the next 23 species present in the Aisemont section are known from the Hanonet Fm. (H), the Trois-Fontaines Fm. (3F), the Terres d'Haura Fm. (TH), the Mont d'Haura Fm. (MH) and the Fromelennes Fm. (F) (COEN, 1985; CASIER & PR AT, 1990, 1991; CASIER *et al.*, 1992): *Amphissites tener omphalotus* (H?, 3F?); *Kozłowskiella boloniensis* MILHAU, 1983 (= *Kozłowskiella* sp. C in CASIER *et al.* (1995) (MH); *Parapribylites hanaicus* (H, 3F, TH, MH); *Kielciella fastigans* (MH); *Coryellina curta* (TH, MH); *Buregia ovata* (3F, TH); *Coeloenellina vellicata* (TH, MH); *Refrathella struvei* (TH?); *Cavellina devoniana sensu* COEN (1985) (H, TH, F); *Poloniella claviformis vel tertia* (H, TH, F); *Eulanella lessensis* (TH); *Polyzygia symmetrica* ((H, TH, F); *Quassilites fromelennensis* (TH, F); *Jenningsina heddebauti* (3F, TH, F); *Jefina romei* (H); *Ropolonellus kettneri* (H, 3F); *Bufina schaderthalensis* (H, 3F, TH, MH); *Cytherellina obliqua* (H, 3F, TH, MH); *Cytherellina groo-*

sae (H, TH, MH); *Bairdiocypris rauffi* (H, 3F); *Bairdia paffrathensis* (H, 3F, TH, MH, F); *Orthocypris cicatricosa* (H, TH, MH) and *Cryptophyllus* sp. 3 (F).

In the Boulonnais (Northern France), the next 16 species are known from the Griset Member (G), the Couderousse Member (C) and the Bastien Member (B) belonging to the Blacourt Fm. (MAGNE, 1964; MILHAU, 1983, 1988): *Amphissites tener omphalotus* (G, B); *Kozłowskiella boloniensis* (G, C, B); *Kozłowskiella* sp. A (= *Parakozłowskiella*? sp. 3B (G); *Coryellina curta* (G, B); *Coeloenellina vellicata* (G, B); *Refrathella struvei* (G, C, B); *Poloniella claviformis vel tertia* (G, C, B); *Polyzygia symmetrica* (G, B); *Bufina schaderthalensis* (G, B); *Cytherellina obliqua* (G, B); *Cytherellina groosae* (G, B); *Cytherellina* cf. *perlonga* (G, C, B); *Healdianella* sp. A (= *Healdianella* sp. A BECKER) (G); *Acratia* sp. G1 (C); *Bairdia paffrathensis* (G, B); and *Cryptophyllus* sp. 3 (G, B).

Several species are also known from other countries, e.g. *Polyzygia symmetrica* is present in Spain, France, Germany, Poland, Morocco, Algeria and Russia; *Bufina schaderthalensis* in Spain, Germany and Poland; *Bairdiocypris rauffi* and *Ropolonellus kettneri* in Germany, Poland and the Czech Republic; *Parapribylites hanaicus*, *Poloniella tertia* and *Bairdia paffrathensis* in Germany and Poland; *Cytherellina groosae* and *Cytherellina obliqua*, in Germany (ADAMCZAK, 1976; BECKER, 1964, 1965, 1989; GROOS, 1969; MALEC & RACKI, 1993; POKORNY, 1950; ZAGORA, 1968; ZBIKOWSKA, 1983).

Position of the Eifelian-Givetian boundary – Correlations with the southern border of the Dinant Synclinorium

Ostracods are very sensitive to environmental changes and consequently correlations based on this group are generally uncertain. Moreover ostracods present in the Jemelle Fm. are poorly known and in the Eifelian Mega-Assemblage, quasi only highly ornamented ostracods belonging to the Metacopina have a biostratigraphic value. Nevertheless the distribution of ostracods in the Aisemont section is compatible with conclusions drawn by GOUWY & BULTYNCK (2003). Only the occurrence of two species of Metacopina, *Quassilites fromelennensis* and *Jenningsina heddebauti*, in our sample 412 is intriguing since these species are unknown in the Jemelle and in the Hanonet Fm. Consequently it is supposed that this sample has been collected above the Eifelian-Givetian boundary, and that a large part of the one m thick transitional zone of GOUWY & BULTYNCK (2003) is of Givetian age and may correspond to a great part of the Hanonet and Trois-Fontaines formations.

Conclusions

Ostracods in the Aisemont section belong exclusively to the Eifelian Mega-Assemblage and their distribution is mainly controlled by the water energy and by strong salinity variations. Assemblages indicative of semi-restricted (Ass. I), agitated (Ass. II) and normal marine

(Ass. III) environments between fair-weather and storm wave bases or below the latter have been recognized in the Aisemont section. The absence of ostracods in several samples is probably indicative of hypersalinity.

The change at the boundary between the Rivière and Névremont formations is abrupt since ostracods are indicative of a marine environment below fair-weather wave base in the lower part of the Névremont Fm. This environment evolves progressively to semi-restricted and lagoonal environments. These conditions persisted during the great part of the Névremont Fm. except at the top where ostracods indicate strong marine influences. Contrary to the Dinant Synclinorium, no assemblage indicative of a real lagoon has been recognized since the variations of salinity are probably too strong or too rapid at Aisemont. Changes of ostracod assemblages close to the Eifelian-Givetian boundary are in agreement with the evolution of facies, and with the position of the boundary between the Rivière and Névremont formations. This interpretation also fits correlations with the southern border of the Dinant Synclinorium (GOUWY & BULTYNCK, 2003). However, the composition of the ostracod fauna in our sample 412 indicates that a large part of their transition zone is of Givetian age.

The sequence stratigraphy analysis highlights an important transgressive event in the upper part of the Rivière Fm., near the Eifelian/Givetian boundary. Such a transgressive event could be related to the Otomari Event (WALLISER, 1983), or to the Kacak Event (HOUSE, 1985) linked to T-R eustatic cycle If of JOHNSON *et al.* (1985). Moreover, the underlying lowstand deposits could be correlated to the Great Gap of STRUVE (1982) defined in the Eifel. This gap has been already reported by GOUWY & BULTYNCK (2003) in the Aisemont section, and by BULTYNCK & HOLLEVOET (1999) in the Couvin area.

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Explanation of Plates

The types are deposited in the collections of the Department of Palaeontology (section Micropaleontology) of the Royal Belgian Institute of natural Sciences (IRScNB n° b...). The thin sections are deposited in the Department of Earth Sciences and Environment of the University of Brussels (Préat n°...). AI... = sample number (see Fig. 3a,b for the stratigraphic position of samples).

PLATE 1

- Fig. 1a,b — *Amphissites tener omphalotus* BECKER, 1964. AI419. Rivière Fm. IRScNB n° b4527. Carapace. a. Right lateral view. b. Dorsal view. X40.
- Fig. 2 — *Amphissites tener omphalotus* BECKER, 1964. AI419. Rivière Fm. IRScNB n° b4528. Right lateral view of a carapace. X60.
- Fig. 3 — *Amphissites* sp. A. AI419. Rivière Fm. IRScNB n° b4529. Right lateral view of a broken carapace. X50.
- Fig. 4 — *Kozłowskiella boloniensis* MILHAU, 1983. AI418. Rivière Fm. IRScNB n° b4530. Left valve. X55.
- Fig. 5 — *Kozłowskiella* sp. A BECKER, 1964. AI101. Névremont Fm. IRScNB n° b4531. Right valve. Right lateral view of a broken carapace. X80.
- Fig. 6a,b — *Youngiella* sp. A, aff. *Ostracode* indet. F5 in MAGNE (1964). AI422. Névremont Fm. IRScNB n° b4532. Carapace. a. Right lateral view. b. Dorsal view. X125.
- Fig. 7a,b — *Roundyella* cf. *patagiata* (BECKER, 1964). AI420. Névremont Fm. IRScNB n° b4533. Carapace. a. Left lateral view. b. Dorsal view. X65.
- Fig. 8a,b — *Parapribylites hanaicus* POKORNY, 1950. AI435. Névremont Fm. IRScNB n° b4534. Carapace. a. Left lateral view. b. Dorsal view. X70.
- Fig. 9a,b — *Kielciella fastigans* (BECKER, 1964). AI435. Névremont Fm. IRScNB n° b4535. Carapace. a. Left lateral view. b. Dorsal view. X60.
- Fig. 10a,b — *Coryellina curta* (ROZHDESTVENSKAJA, 1959). AI435. Névremont Fm. IRScNB n° b4536. Carapace. a. Left lateral view. b. Dorsal view. X65.
- Fig. 11a,b — *Coryellina* sp. A. AI206. Névremont Fm. IRScNB n° b4537. Carapace. a. Left lateral view. b. Dorsal view. X65.
- Fig. 12a,b — *Buregia ovata* (KUMMEROW, 1953). AI418. Rivière Fm. IRScNB n° b4538. Carapace. a. Left lateral view. b. Dorsal view. X35.
- Fig. 13 — *Hollinella* cf. *praecursor* POKORNY, 1950. AI435. Névremont Fm. IRScNB n° b4539. Right broken valve. X40.
- Fig. 14 — *Hollinella* sp. indet. AI412. Rivière Fm. IRScNB n° b4540. Left broken valve. X40.
- Fig. 15a,b — *Ochescapha plana* (KUMMEROW, 1939). AI435. Névremont Fm. IRScNB n° b4541. Carapace. a. Right lateral view. b. Dorsal view. X45.
- Fig. 16 — *Kozłowskiella* sp. A BECKER, 1964. AI419. Rivière Fm. IRScNB n° b4542. Left valve. X65.
- Fig. 17a,b — *Ochescapha*? sp. A, aff. *semicircularis* (KUMMEROW, 1953). AI415. Rivière Fm. IRScNB n° b4543. Carapace. a. Right lateral view. b. Dorsal view. X90.

PLATE 2

- Fig. 1a,b — *Coeloenellina vellicata* COEN, 1985. AI421. Névremont Fm. IRScNB n° b4544. Carapace. a. Right lateral view. b. Dorsal view. X85.
- Fig. 2a,b — *Coelonellina?* sp. A. AI430. Névremont Fm. IRScNB n° b4545. Poorly preserved carapace. a. Right lateral view. b. Dorsal view. X60.
- Fig. 3a,b — *Balantoides* sp. A, aff. *brauni* (BECKER, 1968). AI65. Névremont Fm. IRScNB n° b4546. Carapace. a. Right lateral view. b. Dorsal view. X125.
- Fig. 4 — *Refrathella struvei* BECKER, 1967. AI60. Névremont Fm. IRScNB n° b4547. Left valve. X110.
- Fig. 5a,b — *Samarella* sp. A. AI419. Rivière Fm. IRScNB n° b4548. Carapace. a. Left lateral view. b. Dorsal view. X55.
- Fig. 6 — *Samarella* sp. A. AI419. Rivière Fm. IRScNB n° b4549. Right lateral view of a carapace. X45.
- Fig. 7a,b — *Cavellina devoniana* EGOROV, 1950 *sensu* COEN (1985). AI138. Névremont Fm. IRScNB n° b4550. Carapace. a. Left lateral view. b. Dorsal view. X100.
- Fig. 8a,b — *Cavellina* sp. A, aff. *devoniana* EGOROV, 1950. AI422. Névremont Fm. IRScNB n° b4551. Carapace. a. Left lateral view. b. Dorsal view. X70.
- Fig. 9a,b — *Uchtovia* cf. *abundans* (POKORNY, 1950). AI424. Névremont Fm. IRScNB n° b4552. Carapace. a. Left lateral view. b. Dorsal view. X40.
- Fig. 10a,b — *Poloniella claviformis* (KUMMEROW, 1953). AI435. Névremont Fm. IRScNB n° b4553. Carapace. a. Right lateral view. b. Dorsal view. X55.
- Fig. 11 — *Poloniella claviformis* (KUMMEROW, 1953). AI424. Névremont Fm. IRScNB n° b4554. Left valve of a juvenile. X80.
- Fig. 12 — *Poloniella claviformis* (KUMMEROW, 1953). AI421. Névremont Fm. IRScNB n° b4555. Left valve of a juvenile. X105.
- Fig. 13a,b — *Poloniella cuneata* (KUMMEROW, 1953). AI138. Névremont Fm. IRScNB n° b4556. Carapace. a. Left lateral view. b. Dorsal view. X45.
- Fig. 14a,b — *Eylanella lessensis* CASIER, 1991. AI418. Rivière Fm. IRScNB n° b4557. Carapace. a. Right lateral view. b. Dorsal view. X70.
- Fig. 15a,b — *Eylanella* sp., aff. *mitis* ADAMCZAK, 1968. AI138. Névremont Fm. IRScNB n° b4558. Carapace. a. Left lateral view. b. Dorsal view. X60.
- Fig. 16a,b — *Paraparchitidae?* indet. AI435. Névremont Fm. IRScNB n° b4559. Carapace. a. Left lateral view. b. Dorsal view. X65.

PLATE 3

- Fig. 1 — *Polyzygia symmetrica* GÜRICH, 1896. AI435. Névremont Fm. IRScNB n° b4560. Right valve. X80.
- Fig. 2 — *Polyzygia* sp. A, aff. *symmetrica* GÜRICH, 1896. AI419. Rivière Fm. IRScNB n° b4561. Left valve. X85.
- Fig. 3a,b — *Quassilites fromelennensis* MILHAU, 1983. AI217. Névremont Fm. IRScNB n° b4562. Carapace. a. Right lateral view. b. Dorsal view. X70.
- Fig. 4 — *Quassilites fromelennensis* MILHAU, 1983. AI 419. Rivière Fm. IRScNB n° b4563. X70.
- Fig. 5a,b — *Jenningsina heddebauti* MILHAU, 1983. AI419. Rivière Fm. IRScNB n° b4564. Right lateral view of a carapace. X65.
- Fig. 6 — *Jenningsina* sp. A, aff. *heddebauti* MILHAU, 1983. AI424. Névremont Fm. IRScNB n° b4565. Left valve. X115.
- Fig. 7a,b — *Jefina romei* COEN, 1985. AI419. Rivière Fm. IRScNB n° b4566. Carapace. a. Right lateral view. b. Dorsal view. X110.
- Fig. 8a,b — *Ropolonellus kettneri* (POKORNY, 1950). AI419. Rivière Fm. IRScNB n° b4567. Carapace. a. Right lateral view. b. Dorsal view. X80.
- Fig. 9a,b — *Bufina schaderthalensis* ZAGORA, 1968. AI435. Névremont Fm. IRScNB n° b4568. Carapace. a. Right lateral view. b. Dorsal view. X50.
- Fig. 10 — *Bufina schaderthalensis* ZAGORA, 1968. AI435. Névremont Fm. IRScNB n° b4569. Right lateral view of a carapace of a juvenile. X80.
- Fig. 11a,b — *Bufina* sp. A, aff. *schaderthalensis* ZAGORA, 1968. AI217. Névremont Fm. IRScNB n° b4570. Carapace. a. Right lateral view. b. Dorsal view. X55.
- Fig. 12a,b — *Cytherellina obliqua* (KUMMEROW, 1953). AI419. Rivière Fm. IRScNB n° b4571. Carapace. a. Right lateral view. b. Dorsal view. X95.
- Fig. 13 — *Cytherellina groosae* COEN, 1985. AI430. Névremont Fm. IRScNB n° b4572. Right lateral view of a carapace. X95.
- Fig. 14a,b — *Cytherellina* cf. *perlonga* (KUMMEROW, 1953). AI435. Névremont Fm. IRScNB n° b4573. Carapace. a. Right lateral view. b. Dorsal view. X75.
- Fig. 15a,b — *Cytherellina?* sp. A, aff. *dubia* (KUMMEROW, 1953). AI491. Névremont Fm. IRScNB n° b4574. Carapace. a. Right lateral view. b. Dorsal view. X115.
- Fig. 16a,b — *Tubulibairdia* cf. *clava* (KEGEL, 1932). AI420. Névremont Fm. IRScNB n° b4575. Carapace. a. Right lateral view. b. Dorsal view. X85.

- Fig. 17a,b — *Tubulibairdia* cf. *seminalis* (KUMMEROW, 1953). AI421. Névremont Fm. IRScNB n° b4576. Carapace. a. Right lateral view. b. Dorsal view. X70.
- Fig. 18a,b — *Tubulibairdia* sp. A, aff. *marhoumaensis* CASIER, 1985. AI60. Névremont Fm. IRScNB n° b4577. Poorly preserved carapace. a. Right lateral view. b. Dorsal view. X95.

PLATE 4

- Fig. 1a,b — *Healdianella* sp. A. AI106. Névremont Fm. IRScNB n° b4578. Carapace. a. Right lateral view. b. Dorsal view. X130.
- Fig. 2 — *Bairdiocypris rauffi* KRÖMMELBEIN, 1952. 418. Rivière Fm. IRScNB n° b4579. Right lateral view of a broken carapace. X35.
- Fig. 3a,b — *Bairdiocypris* sp. A, aff. *lamellaris* ADAMCZAK, 1976. AI435. Névremont Fm. IRScNB n° b4580. Carapace. a. Right lateral view. b. Dorsal view. X45.
- Fig. 4a,b — *Bairdiocypris* sp. B. AI424. Névremont Fm. IRScNB n° b4581. Carapace. a. Right lateral view. b. Dorsal view. X30.
- Fig. 5a,b — *Acratia* sp. G1 in MAGNE (1964). AI101. Névremont Fm. IRScNB n° b4582. Carapace. a. Right lateral view. b. Dorsal view. X80.
- Fig. 6a,b — *Bairdia paffrathensis* KUMMEROW, 1953. AI435. Névremont Fm. IRScNB n° b4583. Carapace. a. Right lateral view. b. Dorsal view. X45.
- Fig. 7 — *Bairdia paffrathensis* KUMMEROW, 1953. AI421. Névremont Fm. IRScNB n° b4584. Right lateral view of a carapace of juvenile. X75.
- Fig. 8a,b — *Bairdia* sp. A, aff. *paffrathensis* KUMMEROW, 1953. AI106. Névremont Fm. IRScNB n° b4585. Poorly preserved carapace. a. Right lateral view. b. Dorsal view. X60.
- Fig. 9a,b — *Bairdia* sp. B, aff. *carinata* POLENOVA, 1960. AI419. Rivière Fm. IRScNB n° b4586. Poorly preserved carapace. a. Right lateral view. b. Dorsal view. X50.
- Fig. 10 — *Bairdia* cf. *singularis* KRÖMMELBEIN, 1954 *sensu* OLEMPKA, 1979. AI93. Névremont Fm. IRScNB n° b4587. Right lateral view of a poorly preserved carapace. X45.
- Fig. 11a,b — *Orthocypris cicatricosa* COEN, 1985. AI421. Névremont Fm. IRScNB n° b4588. Carapace. a. Right lateral view. b. Dorsal view. X70.
- Fig. 12a,b — *Orthocypris*? sp. A. AI435. Névremont Fm. IRScNB n° b4589. Carapace. a. Right lateral view. b. Dorsal view. X60.
- Fig. 13 — *Cryptophyllus* sp. 3 in MAGNE (1964). AI128. Névremont Fm. IRScNB n° b4590. Lateral view of a poorly preserved carapace. X60.
- Fig. 14 — *Cryptophyllus* sp. A. AI418. Rivière Fm. IRScNB n° b4591. Poorly preserved valve. X65.

PLATE 5

- Fig. 1 — Bioturbated silty clayey mudstone. Quartz grains (30-50 µm) are concentrated with muscovite flakes in the bioturbated figures. These are limited by irregular clayey pressure solution seams which are also present in the muddy matrix. AI6, Préal n° 3090, microfacies 1, Rivière Fm., scale bar 950 microns.
- Figs. 2, 3 — Thin bioclastic layer ("intermediate tempestite") in a slightly bioturbated clayey and silty carbonate mudstone. Bioclasts consist of brachiopods, bryozoans, ostracods, molluscs. They are partly filled by a ferruginous micrite (zoecia of the bryozoans, infilling of ostracods (Fig. 3). AI412, Préal n° 3099 and 3103, microfacies 3, Névremont Fm., scale bar respectively 950 and 155 microns.
- Fig. 4 — Part of a coral floatstone with a centimetric-sized *Rugosa* fragment. The matrix is finely dolomitized and comprises thin ostracod and echinoderm fragments. The dark zones near the coral are pyrite accumulations. AI437, Préal n° 3187, microfacies 4, Rivière Fm., scale bar 950 microns.
- Fig. 5 — Strongly centripetally pyritized echinoderm fragment in an encrinite with well-developed syntaxial cement (not shown here). The pyritized fragment was formerly micritized (greyish zone corresponding to a former micritic envelope). A thin calcitic vein cuts the bioclast and the pyrite. AI428, Préal n° 3160, microfacies 5, Névremont Fm., scale bar 155 microns.
- Fig. 6 — Pyritized molluscan fragment ("blackened grain") in a bioturbated wackestone (not shown here). The grain is inside a bioturbation figure consisting of a fine-grained microsparite containing small-sized pyrite. AI430, Préal n° 3167, microfacies 5, Névremont Fm., scale bar 155 microns.
- Fig. 7 — Oolitic microsparitized packstone with subrounded micritized grains in a burrowed fine-grained oolitic wackestone (not shown here). The nuclei of oolites consist of ostracods, pyritized pelecypods and micritized crinoids. See Pl. 6, Figs. 1,2 for details of the grains. AI419, Préal n° 3167, microfacies 7, Rivière Fm., scale bar 390 microns.
- Fig. 8 — Pyritized pelecypod bioclast and blackened grains (molluscs, crinoids) in a bioclastic (molluscs, ostracods, echinoderms) microsparite. AI420, Préal n° 3149, microfacies 7, Névremont Fm., scale bar 390 microns.

PLATE 6

- Figs. 1, 2 — Micritized, pyritized and oolitized bioclasts (crinoids, gastropods, pelecypods) in an oolitic packstone (see Pl. 1, Fig. 7). Pyritization precedes oolitization. AI419, Pr  at n   3134 and 3141 respectively, microfacies 7, Rivi  re Fm., scale bar respectively 155 and 390 microns.
- Fig. 3 — Nodular Codiacean (*Ortonella*) bindstone with small idiotopic dolomite crystals. AI194, Pr  at n   3212, microfacies 9, N  vremont Fm., scale bar 155 microns.
- Figs. 4,7 — Centimetric-sized (up to 2 cm) angular microbreccia in an oolitic, bioclastic and lumpy intraformational microconglomerate. The microbreccia consists of a bioclastic (ostracods, pelecypods) wackestone. Microspar is irregularly distributed. Fig. 7 shows reworked *Palaeomicrocodium* lumps. AI206, Pr  at n   3228 and 3241 respectively, microfacies 11, N  vremont Fm., scale bar respectively 950 and 155 microns.
- Figs. 5,6 — Cryptalgal peloidal bindstone. AI206, Pr  at n   3228 and 3241 respectively, microfacies 11, N  vremont Fm., scale bar respectively 950 and 155 microns.
- Fig. 8 — Laminite consisting of millimetric alternations of smooth flat lamination of peloidal packstone and dolomitic mudstone. AI180, Pr  at n   3201, microfacies 12, N  vremont Fm., scale bar 950 microns.

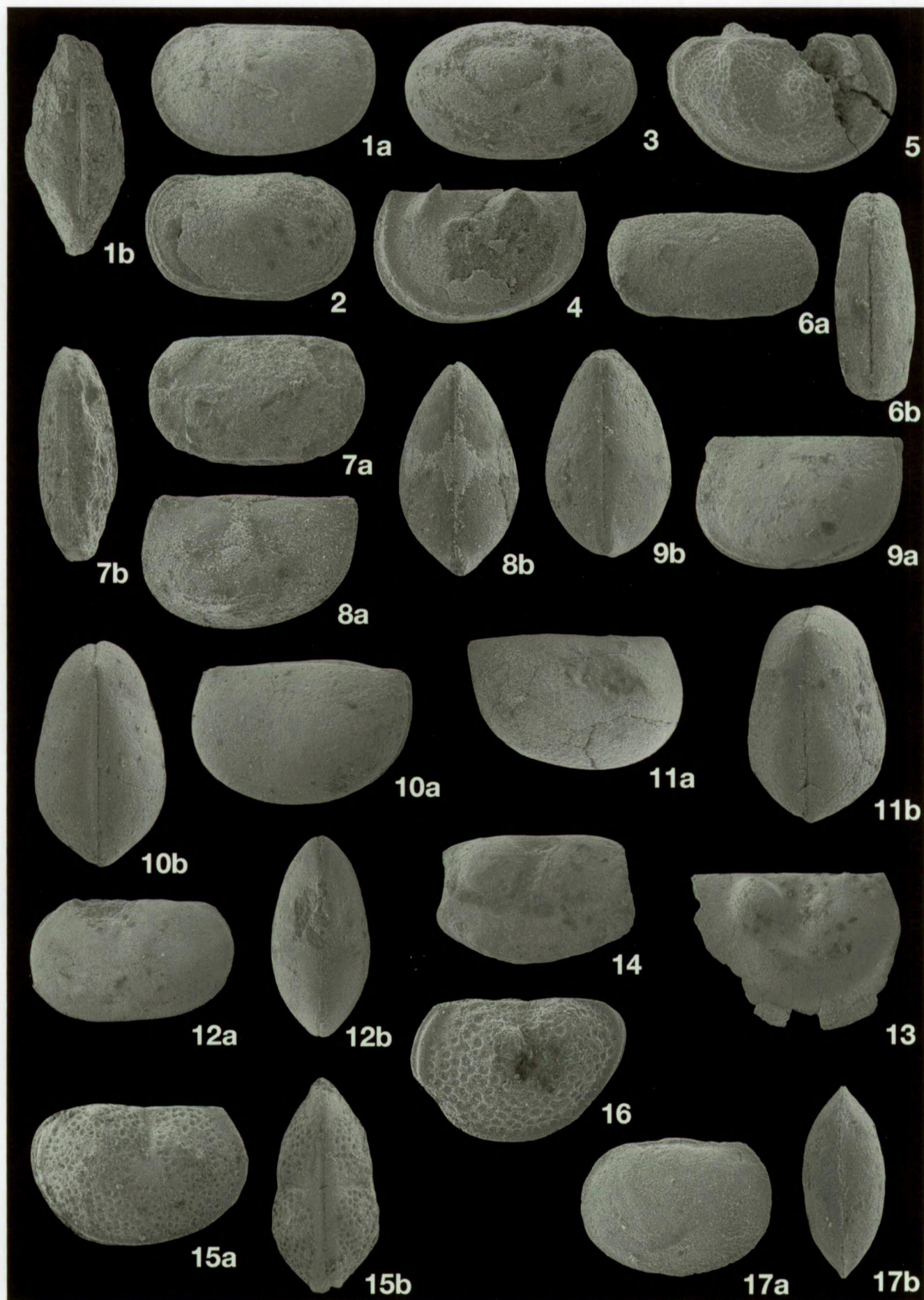


PLATE 1

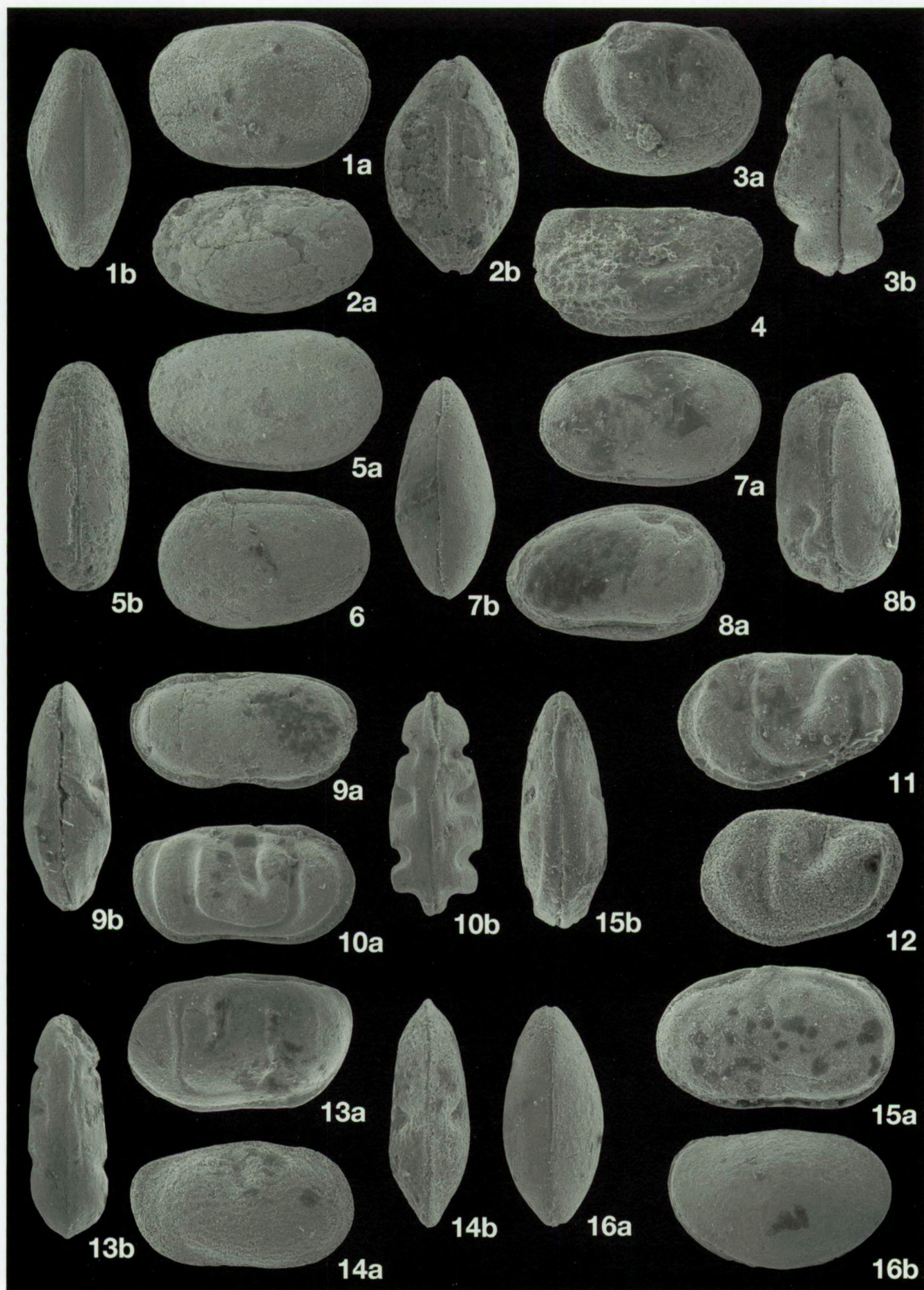


PLATE 2

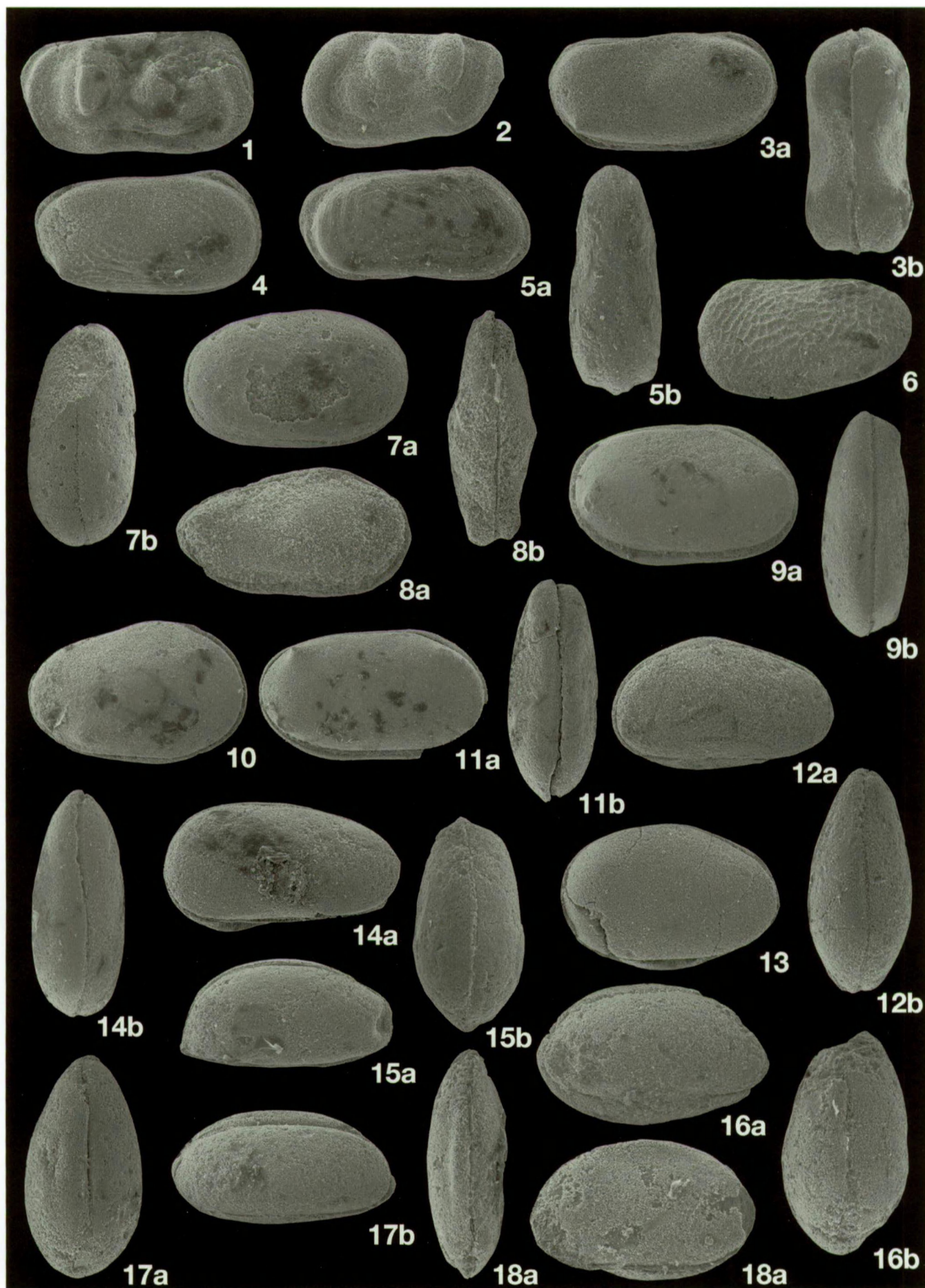


PLATE 3

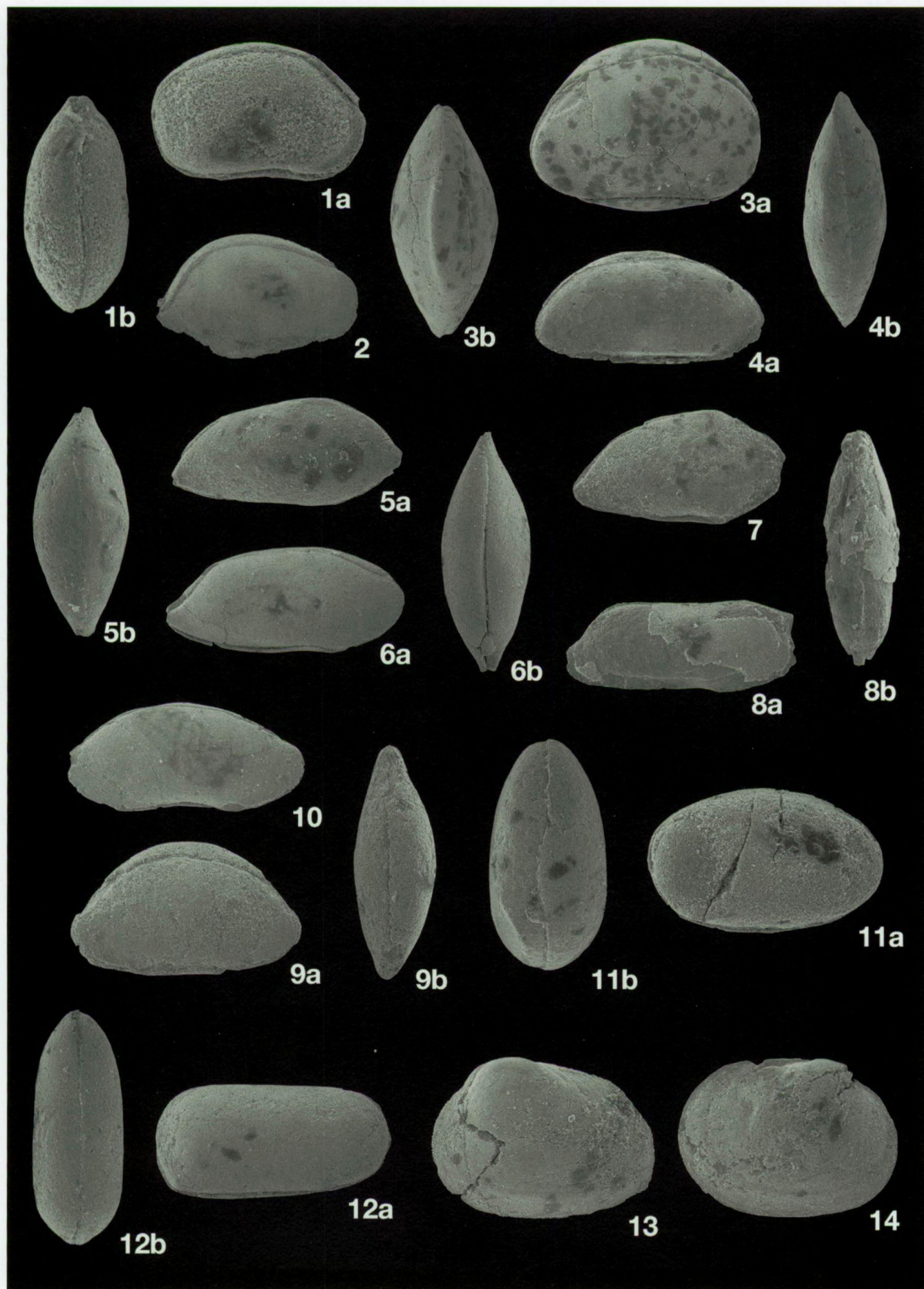


PLATE 4

